ucts such as consumer electronics, telephones, personal computers, and access points for both for home and office.

[0079] A WLAN may be organized as an independent basic service set (IBSS) or an infrastructure basic service set (BSS). Wireless devices or stations (STAs) in an independent basic service set (IBSS) communicate directly with one another and there is no access point in the IBSS. WLAN ad hoc networks have an independent configuration where the mobile devices communicate directly with one another, without support from a fixed access point. WLAN ad hoc networks support distributed activities similar those of the Bluetooth™ piconets. The IEEE 802.11 standard provides wireless devices with service inquiry features similar to the Bluetooth™ inquiry and scanning features.

[0080] The independent basic service set (IBSS) has a BSS Identifier (BSSID) that is a unique identifier for the particular ad hoc network. Its format is identical to that of an IEEE 48-bit address. In an ad hoc network, the BSSID is a locally administered, individual address that is generated randomly by the device that starts the ad hoc network.

[0081] Synchronization is the process of the devices in an ad hoc network getting in step with each other, so that reliable communication is possible. The MAC provides the synchronization mechanism to allow support of physical layers that make use of frequency hopping or other time-based mechanisms where the parameters of the physical layer change with time. The process involves beaconing to announce the presence of an ad hoc network, and inquiring to find an ad hoc network. Once an ad hoc network is found, a device joins the ad hoc network. This process is entirely distributed in ad hoc networks, and relies on a common time base provided by a timing synchronization function (TSF). The TSF may maintain a 64-bit timer running at 1 MHz and updated by information from other devices. When a device begins operation, it may reset the timer to zero. The timer may be updated by information received in beacon frames.

[0082] Each wireless device or STA maintains a TSF timer with modulus 2^{64} counting in increments of microseconds. STAs expect to receive Beacon frames at a nominal rate. The interval between Beacon frames is defined by a Beacon Period parameter of the STA. A STA sending a Beacon frame sets the value of the Beacon frame's timestamp so that it equals the value of the STA's TSF timer at the time that the data symbol containing the first bit of the timestamp is transmitted to the PHY plus the transmitting STA's delays through its local PHY from the MAC-PHY interface to its interface with the antenna or light-emitting diode (LED) emission surface.

[0083] In an ad hoc network, since there is no access point (AP) to act as the central time source for the ad hoc network, the timer synchronization mechanism is completely distributed among the mobile devices of the ad hoc network. Since there is no AP, the mobile device that starts the ad hoc network will begin by resetting its TSF timer to zero and transmitting a Beacon, choosing a beacon period. This establishes the basic beaconing process for this ad hoc network. After the ad hoc network has been established, each device in the ad hoc network will attempt to send a Beacon after the target beacon transmission time (TBTT) arrives. To minimize actual collisions of the transmitted Beacon frames on the medium, each device in the ad hoc network may choose a random delay value which it may allow to expire before it attempts its beacon transmission.

[0084] Once a device has performed an inquiry that results in one or more ad hoc network descriptions, the device may choose to join one of the ad hoc networks. The joining process is a purely local process that occurs entirely internal to the mobile device. There is no indication to the outside world that a device has joined a particular ad hoc network. Joining an ad hoc network may require that all of the mobile device's MAC and physical parameters be synchronized with the desired ad hoc network. To do this, the device may update its timer with the value of the timer from the ad hoc network description, modified by adding the time elapsed since the description was acquired. This will synchronize the timer to the ad hoc network. The BSSID of the ad hoc network may be adopted, as well as the parameters in the capability information field. Once this process is complete, the mobile device has joined the ad hoc network and is ready to begin communicating with the devices in the ad hoc network.

[0085] There are three major types of medium access control (MAC) frames in the IEEE 802.11 protocol: the management frame, the control frame, and the data frame. Management frames provide management services. Data frames carry payload data. Control frames assist in the delivery of data and management frames. Each of these types of MAC frame consists of a MAC header, a frame body, and a frame check sequence (FCS). The header contains control information used for defining the type of 802.11 MAC frame and providing information necessary to process the MAC frame. The frame body contains the data or information included in either management type or data type frames. The frame check sequence is a value representing a cyclic redundancy check (CRC) over all the fields of the MAC header and the frame body field.

[0086] 1. Beacon

[0087] The beacon frame is a management frame that is transmitted periodically to allow mobile devices to locate and identify an ad hoc network. Beacon generation in an IBSS is distributed. The value of the beacon period is included in Beacon and Probe Response frames, and devices or STAs adopt that beacon period when joining the IBSS. All members of the IBSS participate in beacon generation. Each STA maintains its own TSF timer that is used for Beacon Period timing. The beacon interval within an IBSS is established by the STA when the START request primitive is performed within a device to create the IBSS. This defines a series of target beacon transmission times (TBTT) exactly a Beacon Period apart, which is the time at which an ad hoc device must send a beacon. Time zero is defined to be a TBTT. At each TBTT the STA waits for the random backoff interval and then sends a Beacon frame if the random delay has expired and no other Beacon frame has arrived from the IBSS of which the STA is a member during the delay period.

[0088] The beacon frame includes the fields: timestamp, beacon interval, and capability information. The timestamp contains the value of the device's synchronization timer (TSF) at the time that the frame was transmitted. The capability information field is a 16-bit field that identifies the capabilities of the device. The information elements in a beacon frame are the service set identifier (SSID), the supported rates, one or more physical parameter sets, an optional contention-free parameter set, an optional ad hoc network parameter set, and an optional traffic indication map. There is no restriction on the format or content of the 32 byte SSID.